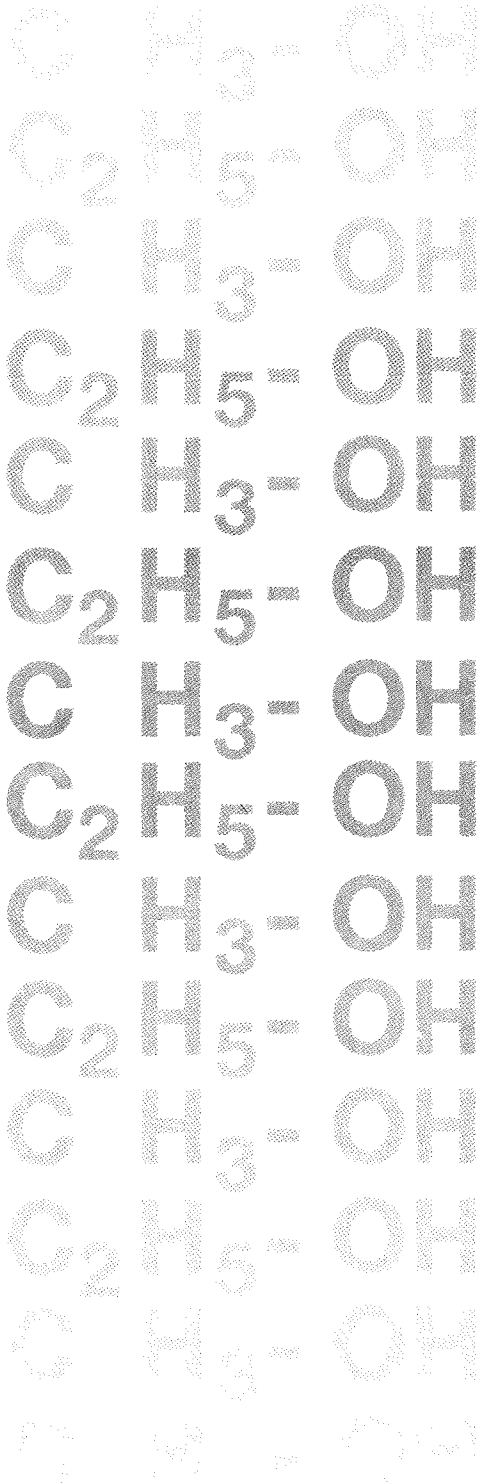
PROPERTIES OF ALCOHOL TRANSPORTATION FUELS



Alcohol Fuels Reference Work #1

Prepared for:
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Office of Alternative Fuels
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During the mid and late 1980s, research on alcohol fuels undertaken in the United States, Japan, and Europe expanded greatly. This research has covered the entire alcohol production, distribution and utilization process, from the selection of high-yield cultivars as feedstocks for the production process to the performance of neat alcohol fuels and blends in production passenger vehicles. Much of the recent research on alcohol fuel utilization has been undertaken by or funded by the R&D departments of private firms, as they seek new fuel and vehicle combinations to meet projected environmental and efficiency requirements for the 1990s. The state-of-the-art has been evolving very rapidly, as public and private sector groups continue research and development efforts that will lead to expanded alcohol fuel production and usage. The results of this research have been published primarily in journals dedicated to the scientific and engineering community, and have not been broadly disseminated to the public policy community. In addition, new information has been developed incrementally, and no compilation of recent findings is currently available.

At the same time, a broad spectrum of public sector decision-makers have become interested in potential applications of alcohol fuels to solve specific problems. These range from city and state officials, seeking to comply with required reductions in vehicle emissions of carbon monoxide and nitrous oxides, to federal officials currently engaged in follow-up to the recently published National Energy Strategy and examining options to reduce future importation of crude oil and refined petroleum products.

Because of the rapid rate of change in the research knowledge, and the very specific needs of public policy decision-makers, a widening gap has emerged in knowledge of the state-of-the art in alcohol fuels. At the end of 1989, it was therefore determined by the Biofuels Systems Division of the U.S. Department of Energy to develop a series of Alcohol Fuel Reference Works. The publications are targeted specifically at public decision-makers to provide a comprehensive set of current information on all aspects of alcohol fuels, from feedstock growth performance and alcohol's chemical characteristics to infrastructure requirements for widespread sale of neat alcohol fuels.

The following report is the first in a series of Alcohol Fuel Reference Works. It presents a range of scientific and engineering information on the characteristics of alcohol fuels. Research findings and data from the period 1985-1990 are emphasized, although more generic information on characteristics has also been included from standard chemistry, engineering, and petrochemical reference texts published prior to 1985. This reference work is designed to serve as a desk companion for public policy decision-makers, and is organized by ten major topical areas. To facilitate usage, each section of the reference work has been designed to stand alone, with only infrequent cross-references to other sections. Key facts and definitions of terms are provided in a "quick reference" summary at the beginning of each major section. Extensive use of graphics has been made, whenever possible reproducing the full range of information presented in the original research reports.

The major foci of this report are the two primary fuel alcohols -- ethanol (ethyl alcohol) and methanol (methyl alcohol). Where particular research reports examined other alcohol fuels (propyl alcohol, isopropyl alcohol, decyl alcohol, etc.) or alcohol-based ethers (particularly methyl tertiary butyl ether or MTBE and ethyl tertiary butyl ether or ETBE), these results have also been included in the analysis. Due to increased interest in ETBE as a means for reformulating gasoline to meet the requirements of the 1990 revisions to the Clean Air Act, a separate section on ETBE has

been included. In the case of engine-related research, there has been a great deal more recent published works on methanol and MTBE than has been published on ethanol and ETBE, and this is reflected in the information presented here. Throughout the series of reference works, however, every attempt has been made to present current research findings on both methanol and ethanol.